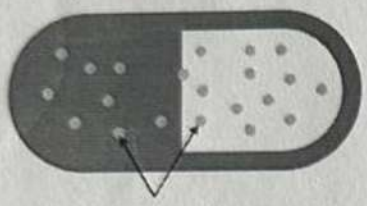
This is the program we need to write today

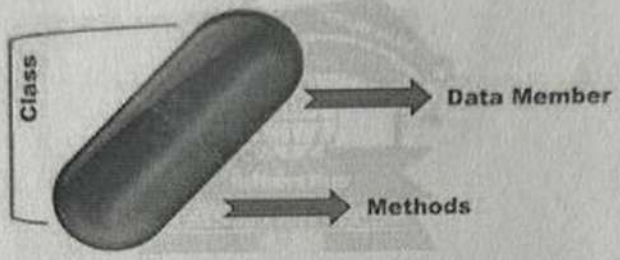
```
class ABBA      -
  {
  static void Main(string[] args)
                    // Here's a method called Main.
  {
      System.Console.WriteLine("ABBA!");
   }
  }
```

So there's the keyword class. Unlike C++, in C# all code must be placed in a class.

Encapsulated in a class.



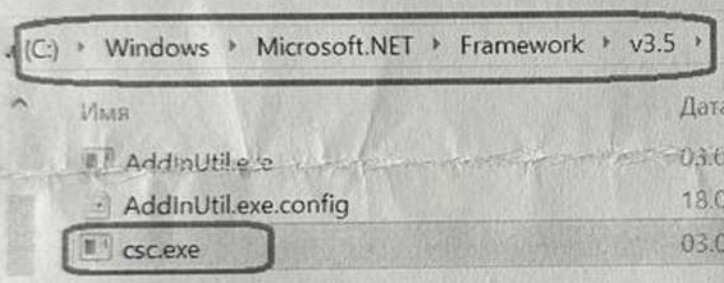
Medicines Inside Capsule



$A \neq a$

C# is case sensitive

C:\WINDOWS\Microsoft.NET\Framework\v3.5\ csc.exe



ABBA.cs => csc.exe = ABBA.exe

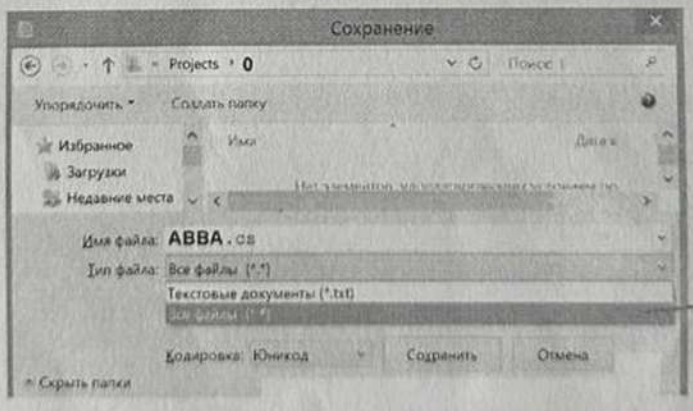
C# Compiler

Step 1. And on my HDD, I also make a folder with the same name D:\ IT

Step 2. In the folder **E:** IT\ we make the folder of the **Projects** - **E:\ IT\Projects**

And in the **Project** folder make folder **0 - E:\ IT\Projects\0** where our today's practical work will be stored

Step 3. As I mentioned above, C# is a built-in language of Windows. Notepad is enough to write a program



You need to switch from *.txt (Text documents) to *.* (all files)

Otherwise, notepad with *.txt extension

Step 4.Entering command mode

Start=>Run=>cmd

cd E: - After that go to the folder IT/Projects/0/

cd IT -Then go to the folder Projects

cd projects - Then go to the folder 0

cd 0 –

```
E:\>cd IT
E:\IT>cd Projects
E:\IT\Projects>cd 0
E:\IT\Projects\0>
```

Step 5.

Now we need to compile the file using the compiler csc.exe which is in the folder

C:\Windows\Microsoft.NET\Framework\v3.5

C:\WINDOWS\Microsoft.NET\Framework\v3.5\csc.exe ABBA.cs

the result is a file ABBA.exe that can already be run (which is located in the same folder). If you have taken the 1st step, then this means that the education-process has begun. This is victory. csc /target:library ABBA.cs - will make ABBA.dll.

```
>ABBA
ABBA
```

Step 6. Modify the file as follows

```
using System;

class ABBA
{
  static int Factorial(int n)
  {
    if (n == 1) return 1;
    return n * Factorial(n - 1);
  }

  static void Main(string[] args)
   // Here's a method called main.
   {
        System.Console.WriteLine("ABBA -"+
                                  Factorial(4));
   }
  }
```

```
>C:\WINDOWS\Microsoft.NET\Framework\v3.5\csc.exe ABBA.cs

>ABBA
ABBA – 24
```

Step 7. Modify the file as follows

```
using System;

class ABBA
{
  static int Factorial(int n)
  {
   if (n == 1) return 1;
    return n * Factorial(n - 1);
   }

public static void Main()
 {
  System.Console.WriteLine("ABBA");
  System.Console.Write("Enter number of Vovels:");
  string s = Console.ReadLine();
  int vovels=int.Parse(s);
  System.Console.Write("Enter number of Consonants:");
  s=System.Console.ReadLine();
  int consonants=int.Parse(s);
  Console.WriteLine(Factorial(vovels)*Factorial(consonants) );
  }
}
```

```
>ABBA
ABBA
Enter number of Vovels:2
Enter number of Consonants:2
4
```

```
>ABBA
ABBA
Enter number of Vovels:3
Enter number of Consonants:3
36
```

1 2 3 4

(+0,1) 11.2.2026 (+0,1) 14.2.26

80% chance of rain in Oxford. Weather Predictions

Traditional method

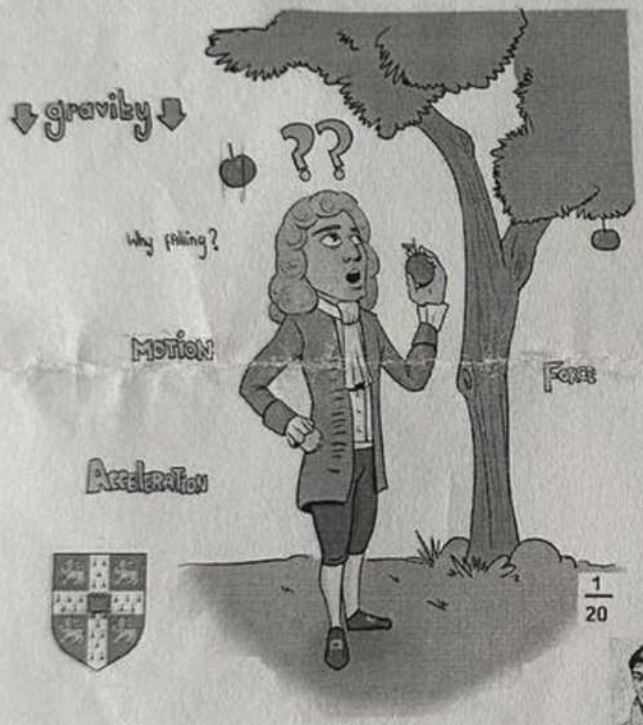
may be less effective

Better learning method

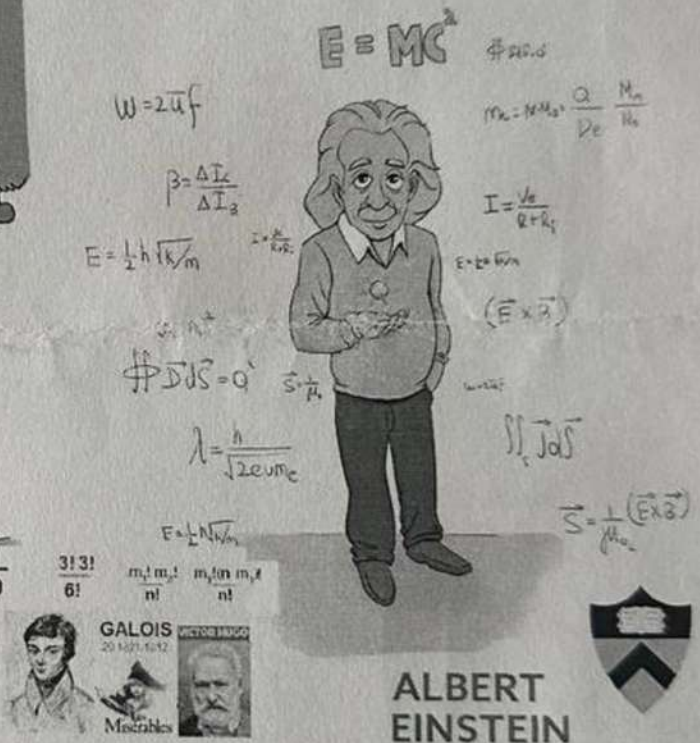
1 listening
2 first way of processing
3 Writing, incl sth., you're not quite sure about

School ↓ graviky ↓ MOTION ==formalism==> University $E=MC^2$ $\oint \vec{S}\,d\vec{S}$ $\iint_S \vec{J}\,d\vec{S}$

CONCRETE AND ABSTRACT THINKING



ISAAC NEWTON



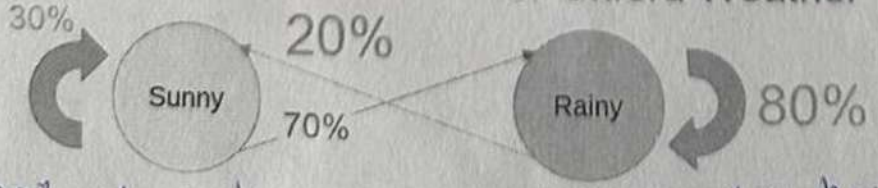
ALBERT EINSTEIN

Motivation: 80% chance of rain

Let A_j be the event of rain at 9am on day j of this term, $1 \le j \le n$

Suppose the events A_j are independently

Markoff Chain Probability Model for Oxford Weather



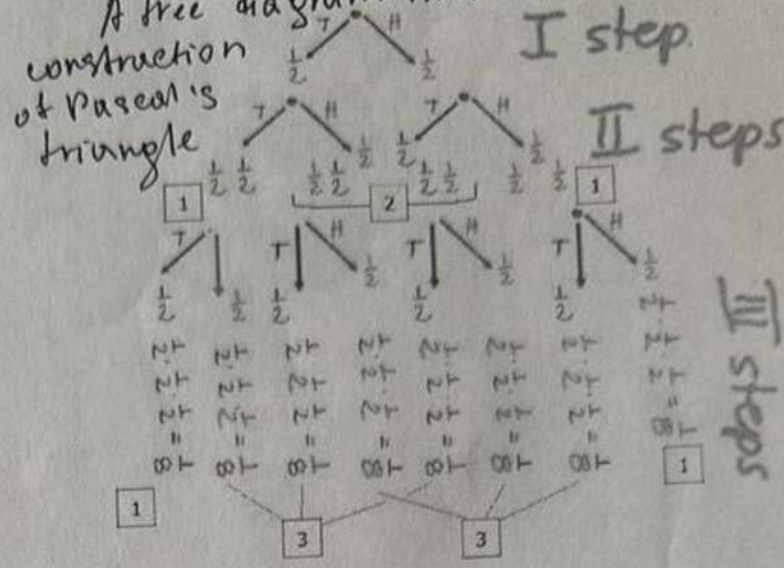
30% chance to stay Sunny
70% to switch to Rainy

80% to stay Rainy
20% to switch to Sunny

Pascal's triangle

0	1							1
1	1	1						2
2	1	2	1					4
3	1	3	3	1				8
4	1	4	6	4	1			16
5	1	5	10	10	5	1		32
6	1	6	15	20	15	6	1	64
	1	7	21	35	35	21	7	1	128

~~A 3 step~~ A tree diagram that illustrate the construction of Pascal's triangle



Newton's Binomial

$$(a+b)^0 = 1$$

$$(a+b)^1 = a + b$$

$$(a+b)^2 = a^2 + 2ab + b^2$$

$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$$

$$(a+b)^5 = a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$$

$(a+b)^6 = a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$

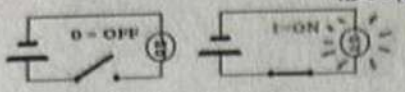
...

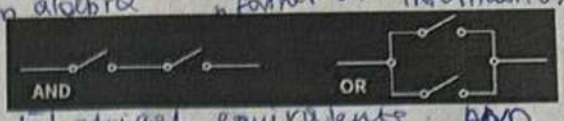
Massachusetts Institute of Technology (MIT)

Lecture by Pr. Bob Gallagher

Boole (1815-1864) & **Shannon** (1916-2001)

Boolean algebra — father of information theory





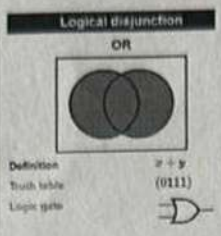
Electrical equivalents: AND OR

Symbols
∧ - and
∨ - or
¬ - not

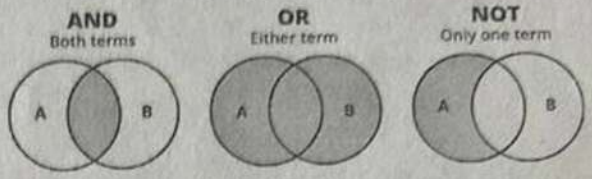
Logical addition (disjunction)

A	B	F=A∨B
0	0	0
0	1	1
1	0	1
1	1	1

A	B	$A \vee B$
True	True	True
True	False	True
False	True	True
False	False	False



BOOLEAN LOGIC

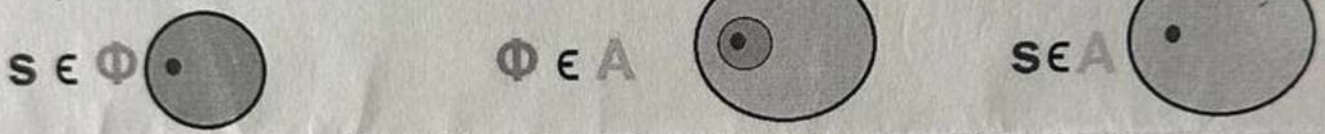


Good logic

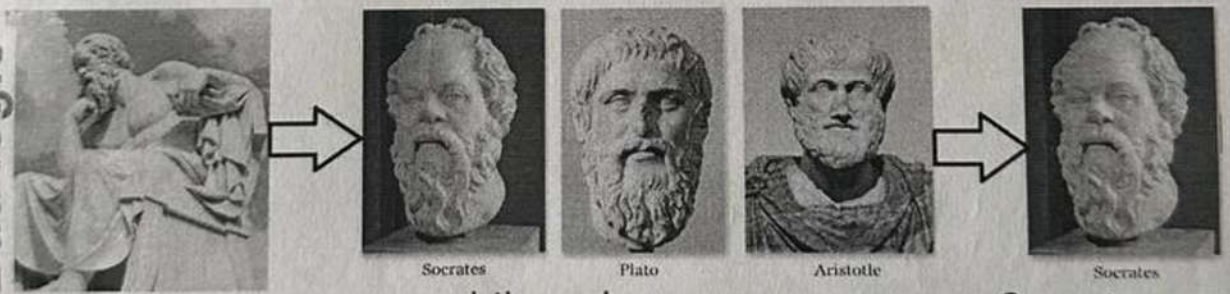
Socrates was a philosopher

philosophers are men

Socrates was a man



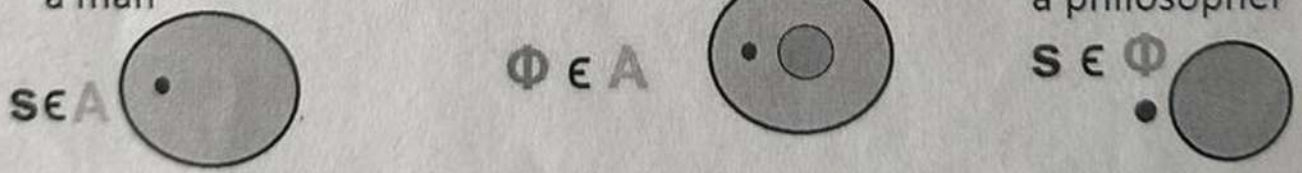
Bad logic

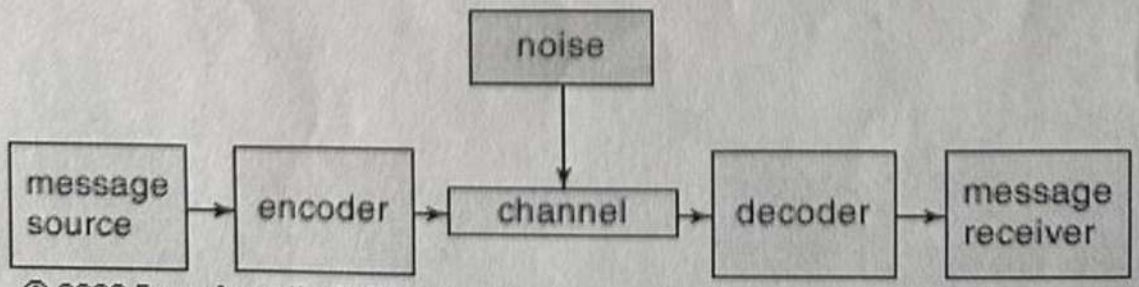


Socrates was a man

philosophers are men

Socrates was a philosopher





Resume of Lecture by Pr. Bob Gallagher from MIT

Massachusetts Institute of Technology (MIT)

George Boole (1815-1864) developed Boolean logic

The principles of logical thinking have been understood (and occasionally used) since the Hellenic era.

Boole's contribution was to show how to systemize these principles and express them in equations (called Boolean logic or Boolean algebra).

Claude Shannon (1916-2001) showed how to use Boolean algebra as the basis for switching technology. This conribution systemized logical thinking for computer and communication systems, both for the design and programming of the systems and their applications.

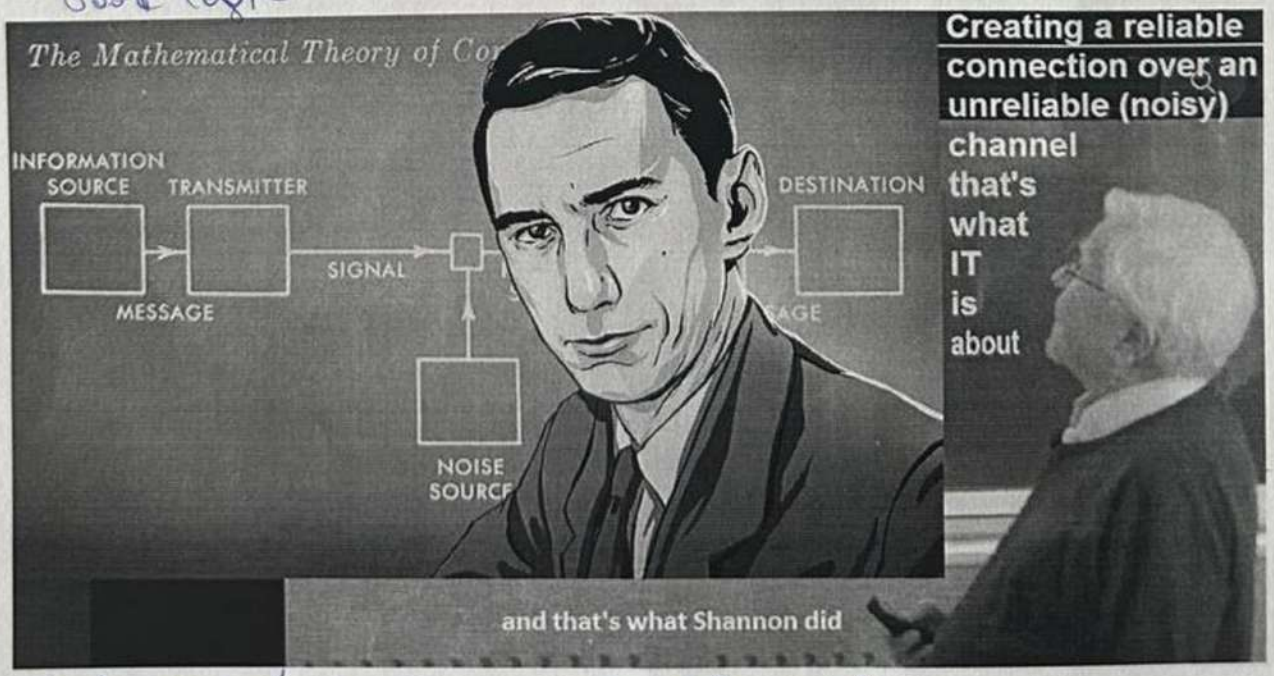
Logic continues to be abused in politics, religion, and most non-scientific areas.

A little nationalistic, but this is an sample of right logic

Kant, Gauss, Goethe are great → Kant, Gauss, Goethe - Germans → Germany Great

The logical structure is valid.
Good logic

Bad logic (abuse of logic)

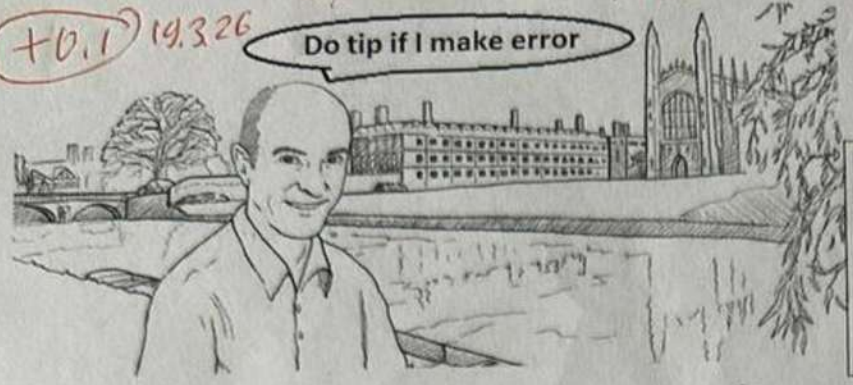


A diagram of a communicational system

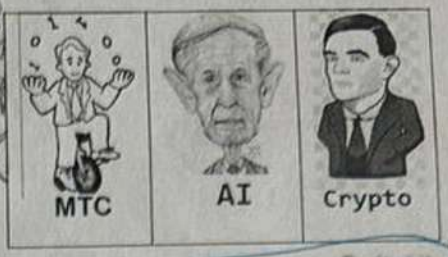
+0.1
24.3
+0.1
25.3

90% 10%
90% 10%
+0.1 19.326

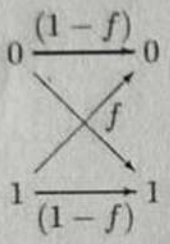
10%
0.1 · 0.1 = 0.01
99%

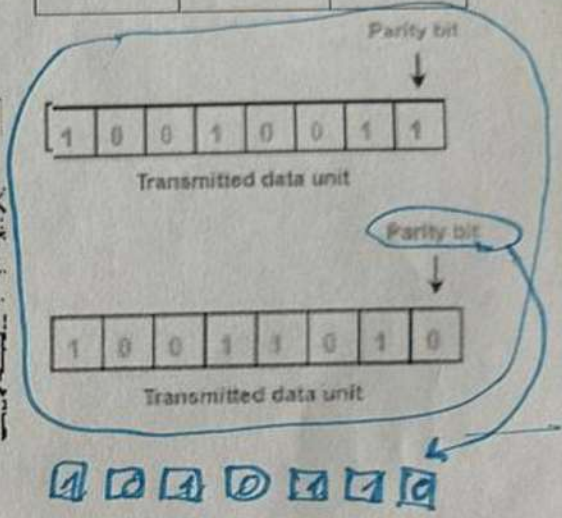


Sir **Dr. D. MacKay,**
University of Cambridge
(22 April 1967 – 14 April 2016)



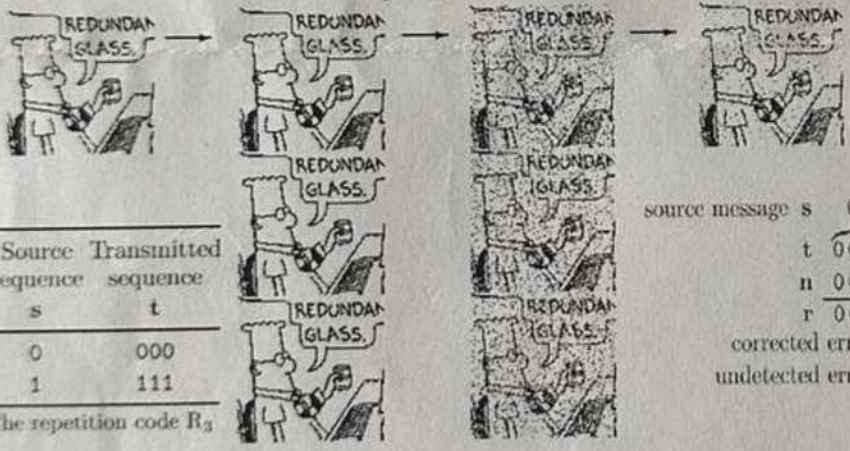
"I believe in clean energy,
but I also believe in mathematics"





1 0 1 0 1 1 0

s ENCODER t CHANNEL r DECODER ŝ
$f = 10\%$



+0.1

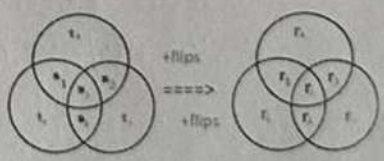
1 1 0 1 1 1 0

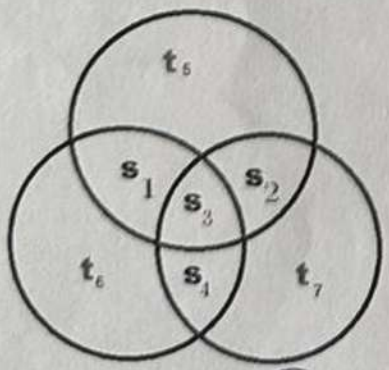
Source sequence s	Transmitted sequence t
0	000
1	111

The repetition code R_3

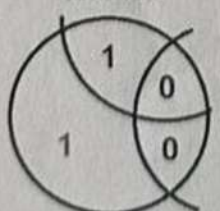
source message	s	0	0	1	0	1	1	0
	t	000	000	111	000	111	111	000
	n	000	001	000	000	101	000	000
	r	000	001	111	000	010	111	000
corrected errors			*					
undetected errors						*		

7.4. Hamming code. $\frac{4}{\Sigma} \rightarrow \frac{7}{t}$



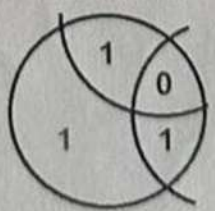


satisfied

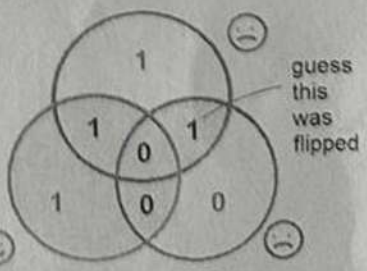


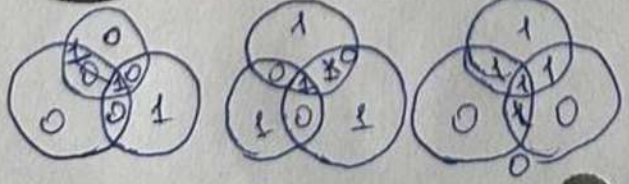
1+1+0+0=0

not satisfied



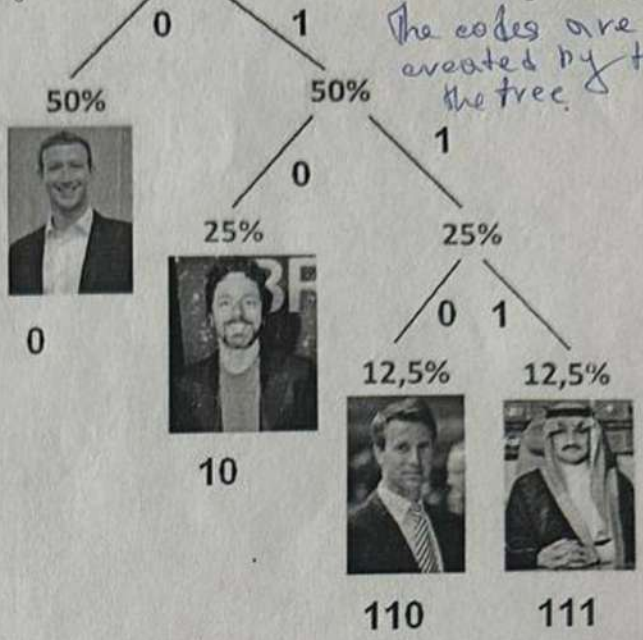
1+1+0+1=1





+0.1

Huffman Tree. Each character is assigned with a binary code, based on its frequency. The higher frequency, the closer to the root => shorter codes



The codes are created by traveling the tree.

Each symbol is independent of the others. The prob. of each symbol appearing doesn't depend on previous symbols

First-order approximation (symbols independent but with frequencies of Belarusian txt).

Мама мыла ра

М - 3 — 30%		1-3 М
а - 4 — 40%		4-7 а
ы -1 — 10%		8 -ы
л - 1 — 10%		9 -л
р - 1 — 10%		10 -р
10		

лламаммар

1-order approx.

Мама мыла ра

Ма - 2	22%	1-2	ма
ам - 2	22%	3-4	ам
мы - 1	11%	5	мы
ыл - 1	11%	6	ыл
ла - 1	11%	7	ла
ар - 1	11%	8	ар
ра - 1	11%	9	ра
9			

0.4673191673 5

ам ыл ла ам ма ра ма ыл ла ам мы

мылла рама

2-order approx.

Pairs of symbols, where the prob. of a symbol appearing depends on the previous symbol

Second-order approximation (digram (2-symbols) structure as in Belarusian)

+0,1 +0,1

Say NO to the **first**

Say YES to the **second** if it is better than the first

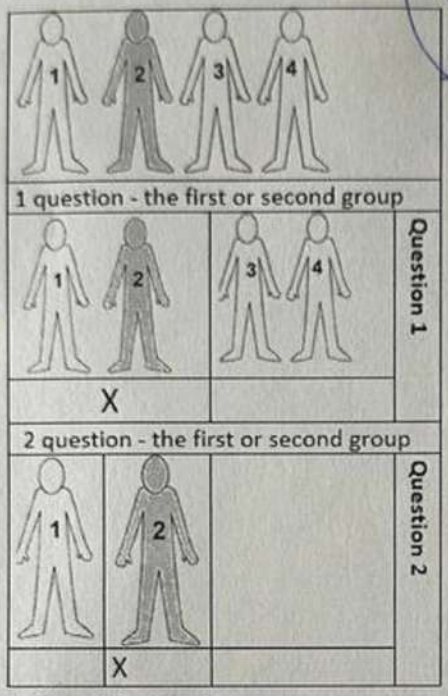
Say **NO** to the **third** only if it is worse than all the others

How determine the average number of questions to find a specific person based on the P

Shannon entropy

(equal probabilities)

The process (comparing candidates in pairs) to determine the best option



Average number of questions =

2*0.25+ 2*0.25+ 2*0,25+ 2*0,25 =2

Average number of questions =

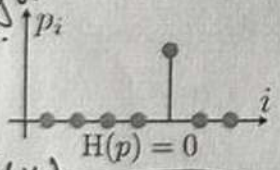
1*0.5+	2*0.25+	3*0,125+	3*0,125
			

Question 1. Is this Zuckerberg?	 50%	1*0.5
Question 2. Is this Sergey Brin?	 25%	2*0.25
Question 3. Is this Stefan from BMW?	 12,5%	3*0,125
So Prince Saud	 12,5%	3*0,125
Average number of questions = 1,75 ←		

Shannon entropy

The measure of uncertainty of inf. content.

$$H(X) = \sum_{i=1}^{n} p(x_i) \log_b \frac{1}{p(x_i)}$$

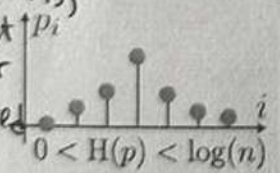


$$\sum_{i=1}^{n} p(i) \log_2 \frac{1}{p(i)}$$

prob. of event. i

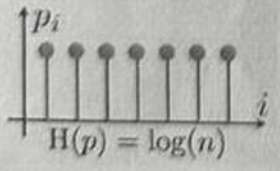
Quantifying information

Inf. content $I(x_i)$, of a single event x_i, the number of bits required to encode that event

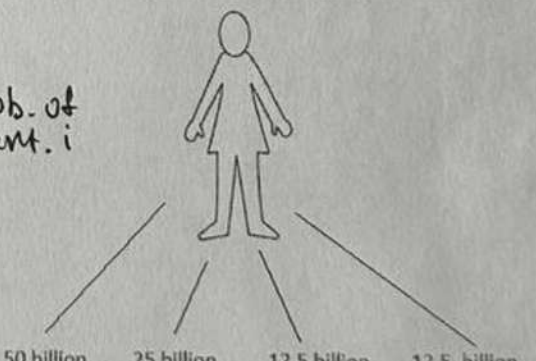


$$I(x_i) = \log_2\left(\frac{1}{p_i}\right)$$

number of bits required to encode choice



$$\sum_{i=1}^{n} p(x_i)\, I(x_i)$$



Mark Zukerberg P(1)= 50%

Sergey Brin P(2)= 25% 2 bits

Stefan Quandt P(3)= 12,5% 3 bits

Prince Al Saud P(4)= 12,5% 3 bits

+0.3

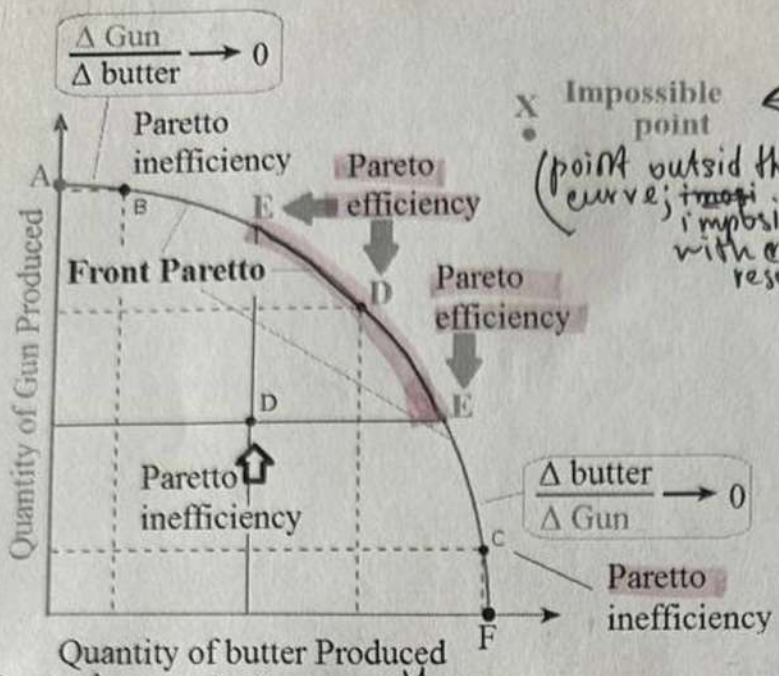
70 10 10 10

$\log_2 \frac{1}{0.7} \approx 0.5$

$\log_2 \frac{1}{0.1} \approx 3.3$

$0.5 \cdot 0.7 + 3.3 \cdot 0.1 + 3.3 \cdot 0.1 + 3.3 \cdot 0.1 \approx 1.84$

$0.7 + 2 \cdot 0.1 + 3 \cdot 0.1 + 3 \cdot 0.1 = 1.5$



X Impossible point (point outsid the curve; impossible with current resources)

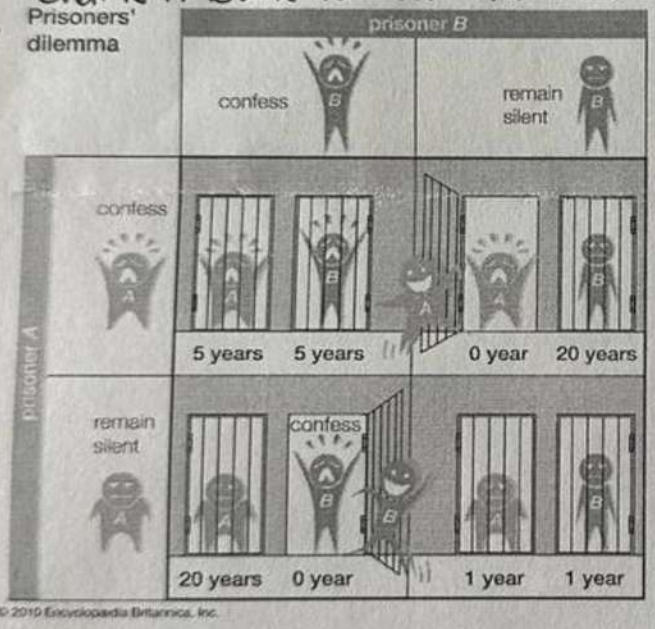
by Vilfredo Pareto

1848-1923

The orange sector E-D-E is the most Pareto efficient - since an increase in one indicator leads to a decrease in another.

A standart example in game theory, shows why individuals might not cooperate even if it would be better results for everyone.

Prisoners' dilemma



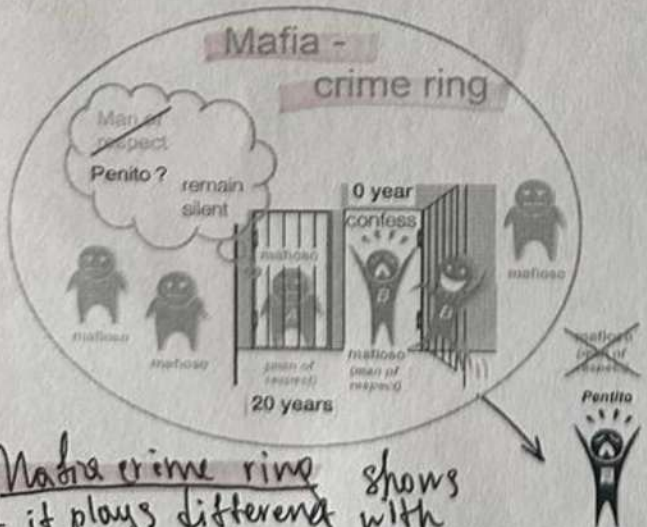
Game Theory

Nash Equilibrium

** => **Nash equilibrium**

$H_2(x)$ / $H_1(x)$	*Player 2*	Recognition;	Non-recognition;
Player 1		1	2
Recognition;	1	* -5 / -5 *	-20 / 0
Non-recognition;	2	0 / -20	-1 / -1

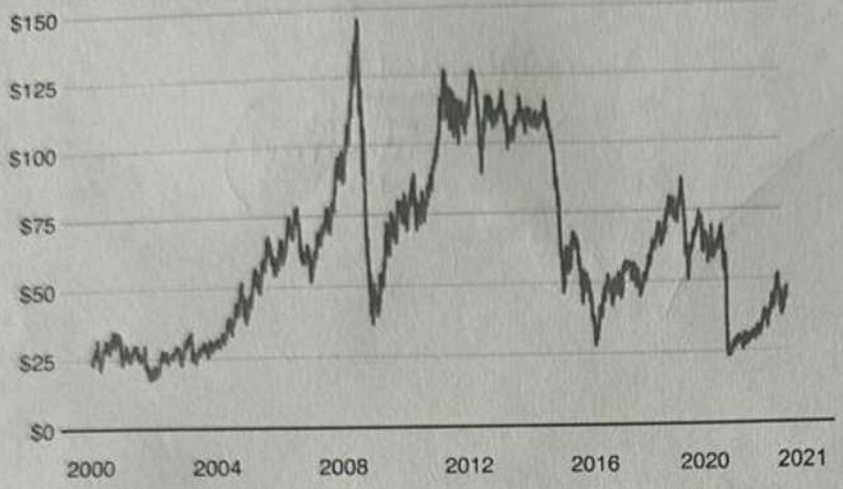
-1-1 Pareto Optimality



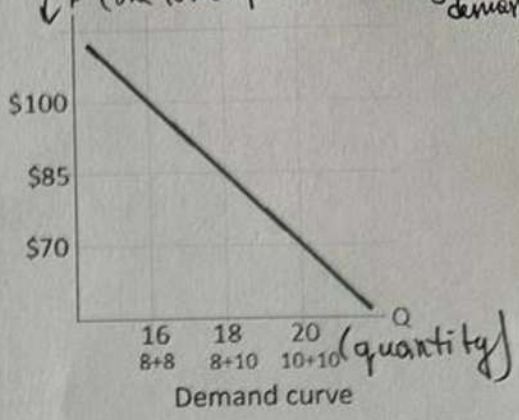
Mafia crime ring shows that it plays different with mafioso, as even one confesses he become „pentito" and stoped to be a „man" of respect.

Nash equilibrium is a concept in game theory where all player adopt strategies that are the best response to the choices of others.

Historical prices of Brent crude oil. Highlights significant fluctuations + peak 2008.



The law of demand



Game theory matrix. Potential outcomes for different strategies of two players

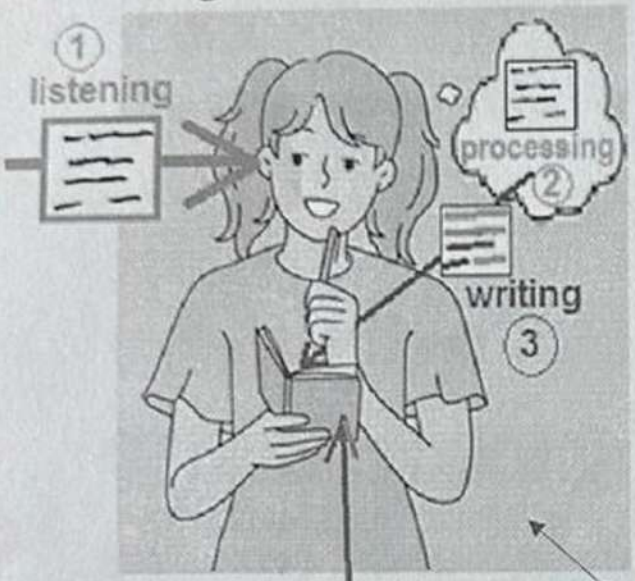
Barrel	1. $8 \cdot 10^6$ barrel/day	2. $10 \cdot 10^6$ barrel/day
1. $8 \cdot 10^6$ barrel	$800 millions per day $100 $800 millions per day	$850 millions per day $85 $680
2. $10 \cdot 10^6$ barrel/day	$680 millions per day $85 $850 millions per day	$700 millions per day $70 $700 millions per day

John Nash (game theory)

consultation

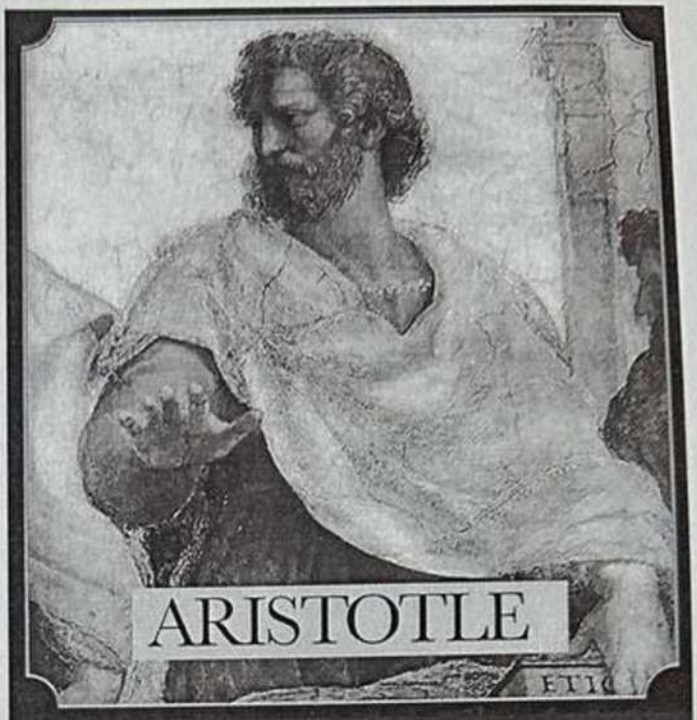
Information Theory

Hearding



Information

The most effective way of learning



My lectures are published and not published;
they will be intelligible to those who heard them, and to none beside
[Letter to Alexander the Great]

Traditional way of learning, less effetive.

$H = K \, lb(N)$

$$\sum_x P(x) \cdot \log\left(\frac{1}{P(x)}\right)$$

Shannon entropy. The measure of uncertainty of inf. content.